Claims

1. In an automotive steering assist system comprising a DC motor having a permanent magnet rotor and a stator including 2m poles subject to shorts, the improvement wherein said poles are organized into first and second m-phase groups, said automotive steering assist system further comprising: means for detecting a short in any of said poles, and means for disabling all of said poles within the m-phase group of a shorted pole which has been so detected.

2. An automotive steering assist system improvement according to claim 1 wherein m=3.

3. An automotive steering assist system improvement according to claim 2 wherein all of said poles within any said pole group are wye connected at a null point.

4. An automotive steering assist system improvement according to claim 1, further comprising means for delivering pulse width modulated driving signals to said poles.

5. An automotive steering assist system improvement according to claim 4 wherein said motor comprises a permanent magnet rotor and a wire-wound stator, said stator having a generally circular cross-section and being wound to define six radially extending poles, which are circularly positioned at regular 60 degree intervals.

6. An automotive steering assist system according to claim 5 wherein said stator is provided with eighteen radially extending spokes, circularly positioned at regular 20 degree intervals, said poles being wound on every third one of said spokes.

7. An automotive steering assist system improvement according to claim 5 wherein said first m-phase group comprises three adjacent ones of said poles, and said second m-phase group comprises three of said poles, diametrically opposing said poles of said first m-phase group.

8. An automotive steering assist system improvement according to claim 5, further comprising means for delivering pulse width modulated driving signals to said poles.

9. An automotive steering assist system improvement according to claim 3, further comprising means for delivering pulse width modulated driving signals to said poles.

10. An automotive steering assist system improvement according to claim 9 wherein said means for delivering pulse width modulated driving signals to said poles comprises:

(a) a DC power source;

(b) a DC power sink;

(c) computing means for generating pulse-width modulated command signal

(c) a pair of inverters of like construction, each comprising: a set of switches connected for directing a flow of current between one of said 3-phase groups of poles and either said DC power source or said DC power sink, the direction of said flow of current being toggled in accordance with the binary state of said pulse-width modulated command signal.

11. In a motor vehicle steering system having a manually operated steering wheel and direction control apparatus responsive to rotational movement of said steering wheel by causing a directional change of said motor vehicle, steering assistance apparatus comprising;

(a) first sensor for generating a first sensing signal indicative of torque being applied to said steering wheel;

(b) a second sensor for generating a second sensing signal indicative of a rotational position of said steering wheel;

(c) computing apparatus programmed to read said first and second sensing signals , and to generate torque assist command signals therefrom, said torque assist command signals being directed into two separate, m-phase, torque assist channels;

(d) a motor having a permanent magnet rotor and a wire wound stator; said stator being provided with 2 groups of m-phase wire wound poles, the poles in each of said pole groups being connected for receiving torque assist commands transmitted by one of said torque assist channels, and able to generate the corresponding torques; and

(e) a short detector for appraising said computing apparatus concerning the existence of shorts in said stator, said computer being programmed to generate control signals which switch off current to the windings of all poles within any channel in which a short has been detected.

12. Steering assistance apparatus according to claim 11 wherein m=3.

13 An automotive steering assist system improvement according to claim 2 wherein all of said poles within any said pole group are wye connected at a null point.

14. An automotive steering assist system improvement according to claim 13, further comprising means for delivering pulse width modulated driving signals to said poles.

15. An automotive steering assist system improvement according to claim 14 wherein said motor comprises a permanent magnet rotor and a wire-wound stator, said stator having a generally circular cross-section and being wound to define six radially extending poles, which are circularly positioned at regular 60 degree intervals.

16. An automotive steering assist system improvement according to claim 15 wherein said stator is provided with eighteen radially extending spokes, circularly positioned at regular 20 degree intervals, said poles being wound on every third one of said spokes.

17. An automotive steering assist system improvement according to claim 15 wherein said first m-phase group comprises three adjacent ones of said poles, and said second m-phase group comprises three of said poles, diametrically opposing said poles of said first m-phase group.

18. A method of reducing adverse effects of a short in a stator of a 3-phase DC automotive steering motor of a type having a permanent magnet rotor, and a wire wound stator provided with 6 poles, said method comprising the steps of:

(1) organizing said 6 poles into 2 groups of 3 poles each;

(2) detecting said short;

(3) identifying the pole wherein said short occurred;

(4) identifying the pole group of the failed pole; and

(5) terminating current flow to all poles in the pole group of the failed pole.

19. A method according to claim 18 further comprising the step of:

(6) physically placing all poles assigned to a first one of said two pole groups semi-circularly side-by-side; and

(7) physically placing all other ones of said poles diametrically opposite corresponding poles of said first one of said two pole groups.

20. A method according to claim 19 wherein said step of terminating current flows is carried out by using pulse-width-modulated signals to turn off transistors supplying current to poles in the pole group of the failed pole.

21. The method of ameliorating the effect of a short in a brushless DC induction motor having a permanent magnet rotor and M three-phase pole, groups, said method comprising the steps of:

(1) detecting the occurrence of said short;

(2) identifying a pole group in which said short occurred; and

(3) disabling all poles in said pole group, so that poles which are not members of said pole group are available for countering drag torques arising as a consequence of said short.

22. A method according to claim 21 wherein the value of M is 2.

23. A method according to claim 22 further comprising the step of operating said poles which are not members of said pole group to assist an operator in the steering of an automotive vehicle.